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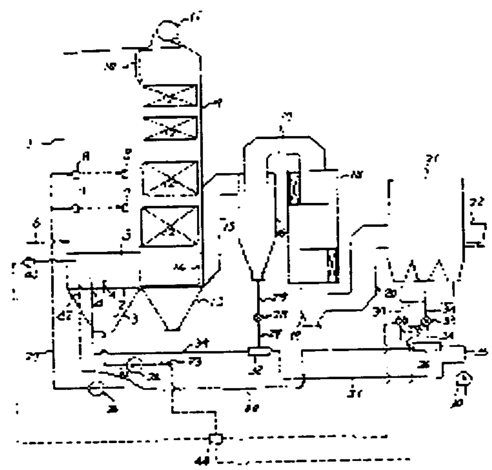
(54) COMBUSTION METHOD FOR FLUIDIZED BED

(57)Abstract:
PURPOSE: To improve combustion efficiency and reduce the generation of NOx markedly by a method wherein the controlled amount of air is supplied into a fluidized bed and remaining air is supplied to the upper part of the fluidized bed and a part of low temp. particles caught from the exhaust gas flowing out of the bed is recirculated into the bed.
CONSTITUTION: Fuel charged from a fuel feeder 6 and solids including unburnt carbon charged from charging nozzles 41, 42 for solids make reaction with a primary air of which quantity is 0.3W0.8 times the theoretical air quantity in a fluidized bed 5 and fuel is gasified and a part of the fuel is burnt to form a primary burning range of reducing atmosphere. Reductive gas etc. generated in the primary combustion range are introduced into the range for unburnt part at the upper part of the bed 5 and overfire air is charged from a nozzle 7 and a denitration reaction is performed. After that, unburnt part of fuel and remaining reducing gas flow into a perfect combustion range to promote perfect burning. The solids caught by a cyclone separator 16 and an electric precipitator 21 of which quantity is 1W5 times the amount of fuel are charged into the bed 5 through the nozzles 41, 42 and the remainder is discharged outside a system.



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FLUIDIZED BED COMBUSTION METHOD

Background of the Invention

1. Field of the Invention

The present invention relates to a fluidized bed combustion method used for a boiler for combusting liquid fuel and low-grade solid material, such as coal, waste oil, sludge, wood-chip and the like, and various heating furnaces.

2. Description of the Related Art

A conventional fluidized bed combustion method will be described below.

1. Bubble Fluidized Bed Combustion Method

(1) A combustion furnace is constituted by a fluidized bed. Fluid material, fuel, air and limestone are supplied into the fluidized bed. Then, Combustion and desulfurization are carried out at the same time.

(2) A heat transfer plane of a super-heater or the like is placed on the upper portion of the fluidized bed.

2. Circulating Fluid Layer Combustion Method

Fuel and air are supplied into the lower portion of a combustion furnace. Moreover, the solid components in combustion gas collected by a high temperature portion of a boiler are again circulated in the lower portion of the

combustion furnace. Then, the solid components together with the fuel and the air are raised from the lower portion of the combustion furnace. The solid components are collected by a high temperature dust collector placed in a backward flue duct. Cleaned gas is further sent to the backward flue duct. The solid components collected by the high temperature portion are again supplied into the combustion furnace after the heat quantity of the solid components is discharged into a heat exchanger placed in a re-circulation system.

[Problems to be solved by the Invention]

1. Bubble Fluidized Bed Combustion Method

(1) In order to absorb a part of the generation heat quantities of all fuels, which are generated in the fluidized bed, to thereby keep a temperature inside the fluidized bed at 850 to 900 ℃, a part of the super-heater and a part of a vaporizer are placed inside the fluidized bed. Since steel pipes constituting the vaporizer and the super-heater are worn by the ash of the fuel, the limestone and the fluid material, they must be exchanged by new pipes in a short period or a build-up repair must be performed on them.

(2) The unburned components dispersed

from the fluidized bed, while they are not combusted, are brought into contact with the heat transfer plane of the upper portion of the fluidized bed and cooled. Then, in the situation that they are not combusted, they are sent out from the boiler. Hence, the loss of the unburned components is high.

(3) Since the desulfurization is carried out in the fluidized bed, the inside of the fluidized bed needs to be held in a state of oxidized atmosphere, which results in a high NOx concentration in an outlet of the combustion furnace.

2. Circulating Fluid Layer Combustion Method

(1) The amount of the solid materials carried by the combustion generation gas passed through the combustion furnace and the backward flue duct is about 10 to 100 times the fuel amount supplied into the combustion furnace. Thus, the metallic deposition portion inside the combustion furnace, the dust collector and the heat transfer plane of the backward flue duct are severely worn.

(2) As for the dust collector placed at the high temperature portion, its size is larger than that placed at the low temperature portion, and it is expensive because of the usage of a heating

resistance material, and its reliability is poor, and it requires an actuation time longer than a limit on a temperature increase rate of a wall surface of the dust collector at a start time.

Summary of the Invention

The present invention is accomplished in view of the above mentioned problems. Therefore, an object of the present invention is to provide a fluidized bed combustion method characterized in that air of an amount adjusted in a range of 0.3 times to 0.8 times of a theoretical combustion air amount is supplied into a fluidized bed formed by a supply of solid fuel, and the remaining air is supplied to an upper portion of the fluidized bed, and a part of low temperature particles collected from exhaust gas exhausted from the fluidized bed, preferably, an amount equal to 1.0 to 1.5 times the supplied solid fuel amount is re-circulated inside the fluidized bed.

Operation of the Invention

The first air of 0.3 to 0.8 times and the low temperature particles containing unburned carbons and the solid fuels are supplied into the fluidized bed. Then, the partial combustion of the unburned carbons and the fuels and the gasification are carried out, which results in

the occurrence of the following endothermic reactions.

(1) $C + O_2 = CO_2 + 97.200$ kcal/moL

(2) $C + 1/2O_2 = CO_2 + 29.200$ kcal/moL

(3) $C + CO_2 \leftrightarrow 2CO - 38.800$ kcal/moL

(4) $C + H_2O = CO + H_2 - 24.400$ kcal/moL

(5) $C + 2H_2O = CO_2 + 2H_2 - 19.400$ kcal/moL

(6) $C + H_2O \leftrightarrow CO_2 + H_2 + 10.000$ kcal/moL

Due to the endothermic reaction of the above-mentioned formulas (3), (4) and (5) and the return of the amount equal to about 1 to 5 times the solid fuel amount in the supply of the 日本文？ collected low temperature particles into the fluidized bed, the inside of the fluidized bed is kept in the reductive atmosphere between 900 and 1000 ℃. Then, the low NOx combustion is done to thereby generate the NOx reductive components (C_nH_m, NH_3 and the like).

The reductive gas (CO, H_2, C_nH_m, NH_3, NH_i and the like) generated in the fluidized bed reacts with slight oxygen supplied through over-fire air, in a reaction portion in the upper portion of the fluidized bed, and triggers the de-nitration reaction as described later. This reaction, if the reductive gas excessively exists as compared with the chemical equivalent of the oxygen, triggers the reductive decomposition of

NO and nitride compound through hydrocarbon, ammonium and the like.

(7) $NO + O_2 + O_nH_m \rightarrow N_2 + H_2O + CO + C_n{}'H_m{}'$

$\rightarrow NH_i + H_2O + CO + C_n{}'H_m{}'$

(8) $NO + NH_3 \rightarrow N_2 + H_2O$

Brief Description of the Drawings

Fig. 1 is a view showing an embodiment to embody the present invention;

Fig. 2 is a graph showing a relation between a first air amount and a temperature inside a fluidized bed; and

Fig. 3 is a graph showing a relation between a circulation amount of solid materials and a combustion efficiency.

Description of the Preferred Embodiment

An embodiment to embody the present invention by using an apparatus shown in Fig. 1 will be described below.

A combustion furnace is configured so as to be surrounded with a combustion furnace wall 1 composed of a water-cooled wall pipe. Also, a furnace bottom 2 is composed of the water-cooled wall pipe. A wind room 3 is placed on a bottom of the furnace bottom 2, and a number of first air nozzles 4 are attached to the furnace bottom 2. A fluidized bed 5 is formed on the furnace bottom 2. A fuel supply

前置詞の使用？

本文と図面だけでは理解不十分

unit 6 for supplying a coal of a solid fuel is installed in an upper portion of the combustion furnace wall 1 above the fluidized bed 5, and an over-fire air nozzle 7 and an additional air nozzle 8 are placed on the further upper portion of the combustion furnace wall 1. A backward flue duct is constituted by a backward flue duct wall 9 composed of the water-cooled wall pipe, adjacently to the combustion furnace. It is linked through a combustion furnace outlet 10 to the combustion furnace. By the way, the water-cooled wall pipe constituting the combustion furnace wall 1 and the backward flue duct wall 9 is linked to a ceiling drum 11. A plurality of heat transfer units 12 are attached to the backward flue duct. A hopper 13 is placed below the backward flue duct. A backward flue outlet 14 is formed on the backward flue duct wall 9 just above the hopper 13, and a flue duct 15 is linked thereto. A back flow end of the flue duct 15 is linked to an inlet of a cyclone separator 16. A flue duct 17 is linked to a gas outlet of the cyclone separator 16. An air pre-heater 18 is placed at a back flow end of the flue duct 17. A hopper 19 is placed below the air pre-heater. A flue duct 20 is linked to a portion just above a hopper 19.

A back flow end of the flue duct 20 is linked to an inlet of a dust collector 21. A flue duct 22 is linked to an outlet of the dust collector 21.

An air outlet of the air pre-heater 18 is linked to the wind room 3 through a first air supply pipe 25 having a damper 23 and a fan 24 in the course thereof and linked to the additional air nozzle 8 and the over-fire air nozzle 7 through a second air supply pipe 27 having a fan 26. An exhaust pipe 29 having an intake valve 28 in the course thereof is attached to a hopper for exhausting solid components of the cyclone separator 16. A lower end of the exhaust pipe 29 is linked to a solid material supplier 32 to which a downstream end of a high pressure piping 31 attached to an outlet of a fan 30 is linked. Also, an exhaust pipe 34 having an intake valve 33 in the course thereof is attached to a hopper for exhausting the solid components of the dust collector 21. A lower end of the exhaust pipe 34 is linked to a solid material supplier 36 to which a downstream end of a high pressure piping 35 attached to an outlet of the fan 30 is linked. An exhaust pipe 37 is branched on an upstream side by the intake valve 33 of the exhaust pipe 34, and an intake valve 38 is also installed in the course of

the exhaust pipe 37.

Solid material air-feeding pipes 39, 40 are attached to outlets of the respective solid material suppliers 32, 36. The respective solid material air-feeding pipes 39, 40 are linked to solid material supply nozzles 41, 42 attached to the furnace bottom 2.

A gas temperature detector 43 for measuring a temperature of the fluidized bed 5 is installed. A signal of the gas temperature detector 43 is transmitted to a controller 44. A signal of the controller 44 is transmitted as a control signal of a driver for driving the damper 23 and the intake valves 33, 38.

The fuels supplied from the fuel supply unit 6 and the solid materials of the amount equal to 1.0 to 1.5 times the fuels, which are supplied from the solid material supply nozzles 41, 42 and contain the unburned carbons, trigger the reactions of the above-mentioned formulas (1) to (6) through the first air of the amount equal to 0.3 to 0.8 times the theoretical air amount, in the fluidized bed 5. The fuels are gasified. A part thereof is combusted to thereby generate a first combustion region of reductive atmosphere between 900 ℃ and 1000 ℃.

This formation of the first combustion region suppresses the NOx generation caused by the combustion, and promotes the de-nitration inside the furnace in the reductive atmosphere.

Reductive gas and the like generated in the first combustion region are introduced into a downward unburned component reaction region by the over-fire air nozzle 7 in the upper portion of the fluidized bed 5. Here, similarly to the fluidized bed 5, the gasified reaction and the partial combustion are carried out.

Over-fire air is supplied from the over-fire air nozzle 7. A de-nitration reaction region is formed between a level of the over-fire air nozzle 7 and a level of the additional air nozzle 8. Here, the temperature inside the furnace is kept at 1000 ℃ or more, and the de-nitration reaction is done as described in the above-mentioned formulas (7), (8). After that, the unburned component and the remaining reductive gas lead to the perfect combustion region. Oxidized atmosphere is generated inside the furnace by the additional air supplied from the additional air nozzle 8. Thus, the perfect combustion of the unburned gas is promoted. Here, the unburned components are perfectly combusted by keeping the temperature

inside the furnace at about 900 to 1300 ℃ and reserving a gas stay time of 1 to 4 seconds.

As for the solid components collected by the cyclone separator 16 and the dust collector 21, the amount equal to 1.0 to 1.5 times the fuel amount is supplied into the fluidized bed 5 through the solid component supply nozzles 41, 42 placed in the fluidized bed 5 by the air feeding. A part of the solid components collected by the dust collector 21 placed at a lower temperature gas portion is supplied into the fluidized bed 5, and the remainder is exhausted from the system exterior. The open degrees of the intake valves 33, 38 are adjusted by the signal from the controller 44 receiving the signal from the gas temperature detector 43 so that a gas temperature of the fluidized bed 5 is kept at a certain value (for example, 950 ℃) at that time. Consequently, the solid materials supplied from the solid material supply nozzle 42 through the solid material air-feeding pipe are controlled.

Also, independently of or in parallel to the control of the above-mentioned solid material supply amount, an open degree of the damper 23 is adjusted by the signal from the controller 44 to thereby control the gas

temperature of the fluidized bed 5. With regard to the control of the gas temperature of the fluidized bed 5, there are two methods of the control of the first air amount and the control of the re-circulation amount of the solid materials collected by the low temperature dust collector. However, the selection with regard to the main and secondary usages of them may be determined on the basis of the property of the fuel, the load and the NOx regulation value.

The above-mentioned operation enables the condition optimal for the NOx suppression to be given to the upper portion and the fluidized bed portion of the combustion furnace without any installation of the heat transfer plane in the fluidized bed. Thus, it is possible to provide the boiler which is low in environmental pollution and high in reliability.

By the way, as the solid materials for the re-circulation, it is allowable to use those collected by the hoppers 13, 19.

Also, the de-nitration can be done in the combustion furnace, in which the over-fire air nozzle 7 and the additional air nozzle 8 are placed in a corner, and a diameter of a virtual circle made by over-fire air supplied from the corner is made smaller, and a diameter of a

virtual circle made by supplying additional air generated thereon is made larger. That is, the reductive gas remains on an outer side of the virtual circle made by the over-fire air. On the other hand, the inside is perfectly combusted through the over-fire air, and NOx is generated. However, the perfect combustion gas (slight O_2 is left) is dispersed to an outer circumference by receiving a centrifugal force from the additional air in the upper portion. The perfect combustion gas (the slight O_2 is left) dispersed to the outer circumference is mixed with the reductive gas outside the virtual circle, which triggers the de-nitration reaction.

Moreover, the de-nitration reaction can be effectively triggered by supplying the over-firing air at many stages and tilting the over-firing air nozzle 7 and the additional air nozzle 8 vertically and horizontally.

The relation between the supply amount of the first air and the circulation amount of the solid materials will be described below by using an actually experimental data.

Fig. 2 shows a graph with respect to an average temperature inside the fluidized bed 5 with respect to a change of an air amount supplied into the fluidized bed 5 from the first

air nozzle 4 when the supply amount supplied from the solid material supply nozzles 41, 42 is changed by 1.0 times, 2.5 times and 5 times the fuel amount supplied from the fuel supply unit 6. However, even from this graph, it is understood that if the air amount is equal to about 0.3 to 0.8 times the theoretical air amount, the reductive atmosphere of the low temperature can be attained by suppressing to a temperature equal to or lower than a softening point of a combustion ash between about 900 to 1000 ℃. Also, it is understood that if the supply amount of the solid materials is five times or more, the temperature inside the fluidized bed 5 is excessively dropped to thereby disable the usage.

Next, Fig. 3 shows a graph illustrating a combustion efficiency with respect to a circulation amount of solid materials. It is understood that if a circulation ratio becomes 1 or less, the combustion efficiency is extremely dropped to thereby disable the usage.

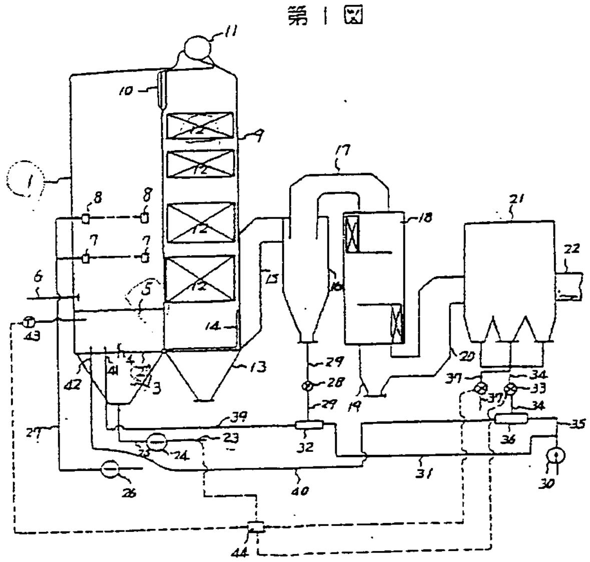
Advantageous Effects of the Invention

According to the fluidized bed combustion method of the present invention, the combustion efficiency can be improved by 2 to 12 %, and the NOx generation can be largely decreased.

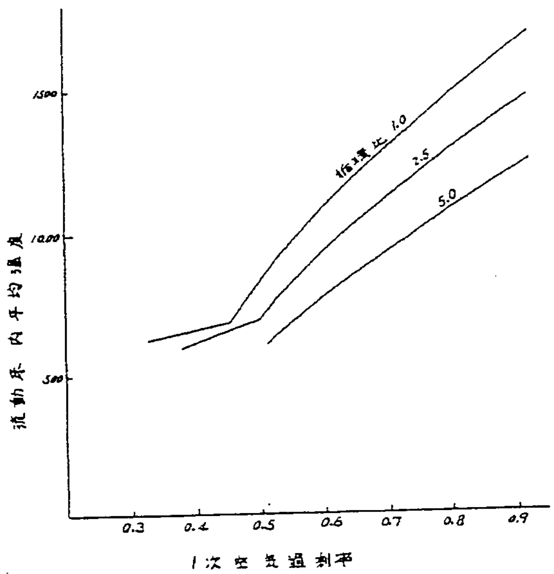
What is claimed is:

A fluidized bed combustion method characterized in that air of an amount adjusted in a range of 0.3 times to 0.8 times of a theoretical combustion air amount is supplied into a fluidized bed formed by a supply of solid fuel, and the remaining air is supplied to an upper portion of said fluidized bed, and an amount equal to 1.0 to 1.5 times the solid fuel amount supplied into said fluidized bed in low temperature particles collected from exhaust gas exhausted from said fluidized bed is re-circulated.

第1図



第2図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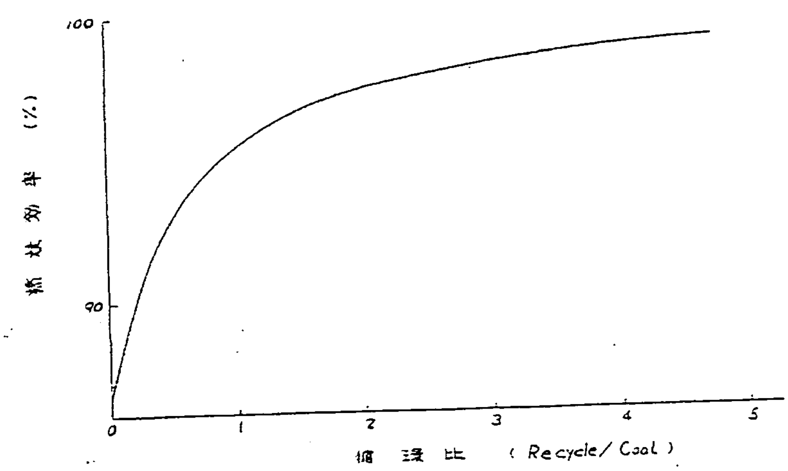
循環比 1.0
2.5
5.0
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1次空気過剰率

第3図


100
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燃焼効率 (%)
0
1
2
3
4
5
循環比 (Recycle/ Coal)